United States
Department of
Agriculture

Forest Service

**Southern Forest
Experiment Station**

New Orleans,
Louisiana

Proceedings Reprint

ANNUAL AND GEOGRAPHIC VARIATIONS IN CONE PRODUCTION BY LONGLEAF PINE

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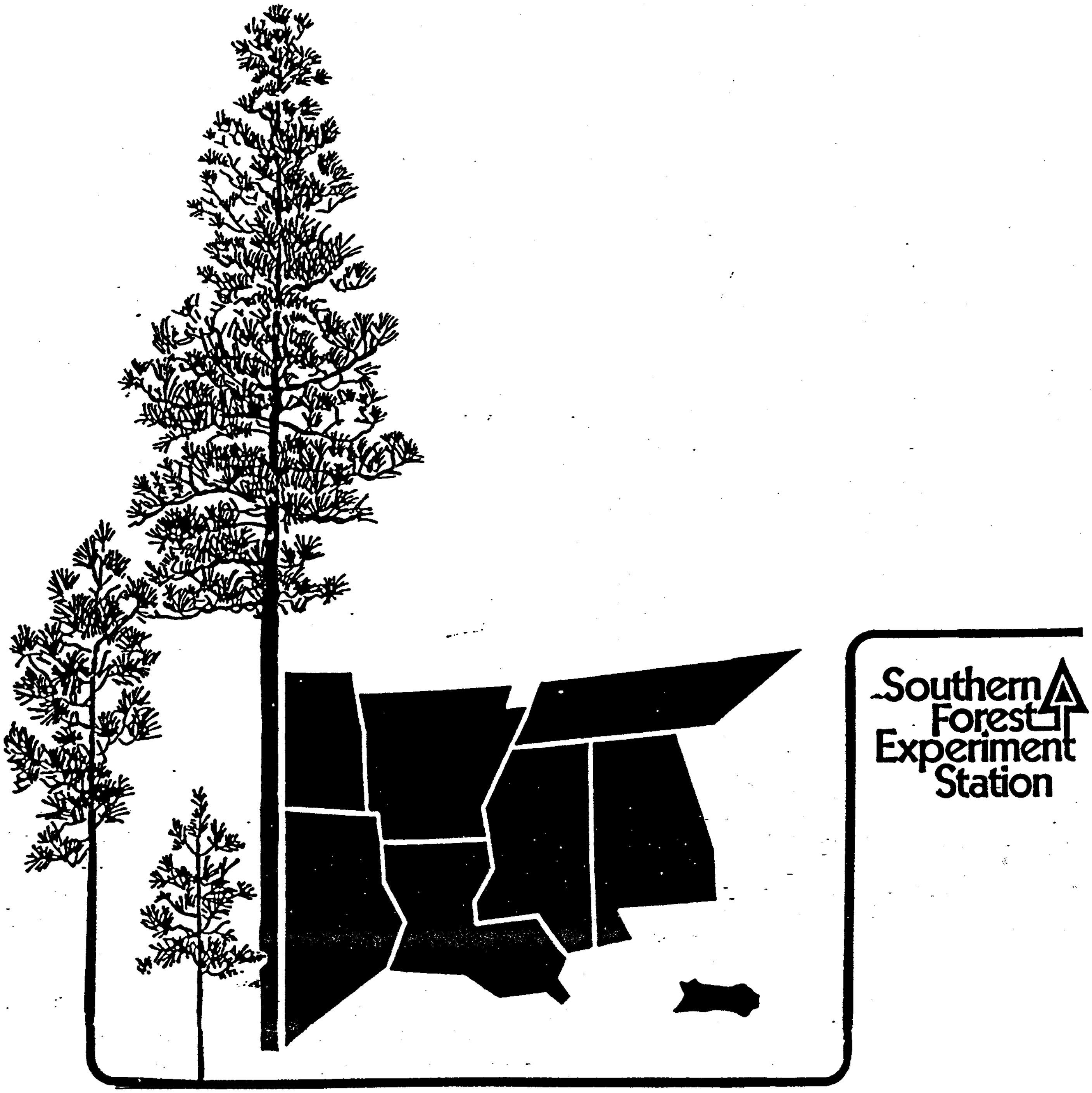
In: Proceedings of the Fourth Biennial Southern Silvicultural Research Conference; 1986 November 4-6; Atlanta, GA: Gen. Tech. Rep. SE-42. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 73-76.



ANNUAL AND GEOGRAPHIC VARIATIONS IN CONE PRODUCTION BY LONGLEAF PINE[1/]

William D. Boyer[2/]

Abstract--Cone production by longleaf pine (Pinus palustris Mill.) has been monitored on sample trees in shelterwood stands since 1966. Eleven locations, three each in Alabama and Florida and one in Louisiana, Mississippi, Georgia, South Carolina, and North Carolina were included in the study. Each location had two test areas, with 50 sample trees each. Six locations had 15 or more years of record, the others less. Annual counts of cones, conelets, and flowers (pistillate strobili) on each sample tree were made until trees were cut. Over 20 years, cone crops in which the average number of cones per tree exceeded 50 occurred only in 1967, 1973, and 1984. The frequency of cone crops potentially useable for natural regeneration (average of 20 or more cones/tree) varied considerably among locations. Cone crop frequency was very low (< 0.1 or 1 year in 10) at two locations in northwest Florida and one in southwest Georgia. Cone crop frequency reached a peak of 0.62 and 0.75 at two locations in central Alabama. The ratio of flowers counted to cones produced suggests that low cone crop frequencies near the Gulf Coast were due more to flower losses than failure to produce flowers.

INTRODUCTION

Longleaf pine is a poor seed producer compared to other southern pines, and cone crops good enough for natural regeneration are relatively infrequent (Boyer and Peterson 1983). Wahlenberg (1946) noted that good crops occur every 5 to 7 years, and failures about 1 year in 5. In south Mississippi over a period of 21 years, there were 9 years in which medium or better cone crops occurred in longleaf pine (Maki 1952). Shelterwood stands in south Alabama produced 5 cone crops adequate for natural regeneration (> 50 thousand seeds/acre) over a period of 19 years (Croker and Boyer 1975). Heavy or bumper seed crops through much of the range of longleaf pine may occur once in 8 to 10 years (Maki 1952).

Very few systematic observations of cone production by longleaf pine have been reported, (e.g., Croker 1973, McLemore 1975). These are normally from a localized area and cover only a few years.

A region-wide test of the shelterwood system of natural regeneration of longleaf pine was initiated in 1966. Data obtained on cone and flower production at test sites have provided information on the variability of longleaf pine cone production over a period of time among several locations across the southeastern United States.

METHODS

Natural regeneration tests for longleaf pine were established at 11 locations ranging from Louisiana to North Carolina (table 1). One test location was the Escambia Experimental Forest, Escambia County Alabama; four were National Forests in Louisiana, Mississippi, Alabama, and Florida; three were State forests in Florida, South Carolina, and North Carolina; two were private lands (Alabama and Georgia); and one was a military reservation (Florida).

At each of 10 locations (the experimental forest excluded), 2 test areas ranging from about 20 to 60 acres in size were established. One tested the two-cut and the other the three-cut shelterwood system. These tests were initiated from 1966 to 1970. Several two-cut tests were located on experimental forest sites. All tests were located in maturing stands of longleaf pine nearing end of a sawlog rotation. Within each test area, 25 sample points were established. The two seed trees nearest each sample point were marked for annual springtime counts of flowers and conelets using the method described by Croker (1971). Cones produced the preceding fall by each sample tree were also counted at the same time. This

1/ Paper presented at the Fourth Biennial Southern Silvicultural Research Conference, Atlanta, Georgia, November 4-5, 1986.

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Table 1.--Study sites and years of observation on longleaf pine cone production

State	County	Years of observation
LA	Grant	15
MS	Perry	8
AL	Coosa	8
	Perry	8
	Escambia	20
FL	Santa Rosa	18
	Okaloosa	15
	Leon	10
GA	Decatur	19
SC	Chesterfield	15
NC	Bladen	8

was the total of cones on the ground under the tree, plus a binocular count of cones remaining in the tree. Sample trees were not replaced when removed through thinning or natural mortality. The number of residual sample trees had dropped to less than 20 on only one area.

The sampling period reported here covers the 20 years from 1966 through 1985. Five locations were represented in the first year, and also the last. The number of years of observation at each of the 11 locations is given in table 1. The 20 years and 11 locations covered in this report result in a total of 220 cells. Of these, 144 included at least one observation (one test area). A total of 110 had two observations (both test areas at a location) and 7, all on the Escambia Experimental Forest, included observations from 3 test areas.

RESULTS

Annual Variation in Cone Production

Cone production by longleaf pine at all locations combined, in terms of average number of cones per tree, ranged from a low of 1 in 1966 to a high of 66 in 1973 (fig. 1). Cone production exceeded an average of 50 cones per tree only in 1967, 1973, and 1984. Cone production averaged less than 20 cones per tree in 13 of the 20 years and less than 10 cones per tree in 9 of the 20 years. Normally, an average of 750 cones per acre is needed to obtain adequate natural regeneration in a longleaf pine shelterwood stand. Shelterwood stands in this study averaged about 30 trees per acre, so an average of 25 cones per tree would be required for successful regeneration. Anything less than 20 cones per tree is likely to be ineffective.

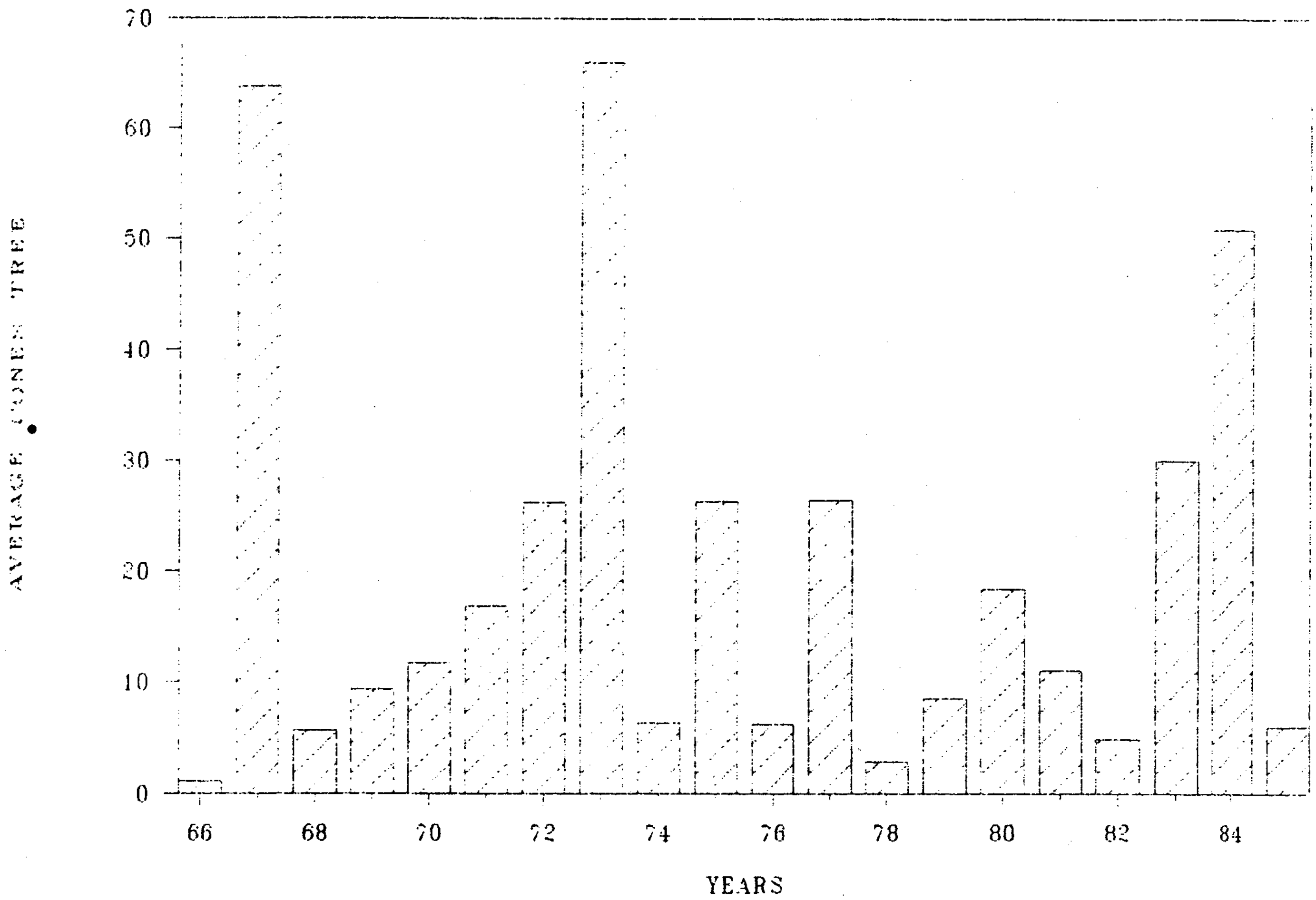

Figure 1.--Annual variation in cone production by longleaf pine for all locations combined.

Variation among Locations in Cone Production

Average annual cone production per tree varied considerably among the 11 locations (table 2). The two locations in the Mountain Province of Alabama had the highest average cone production, with 71 and 86 cones per tree. Locations in northwest Florida and southwest Georgia had the lowest cone production.

Data on average annual cone production were derived from all sample trees for each year of observation. The years of observation varied among locations, and there were also differences among locations in seed-tree size, which affected cone production. All 11 locations provided cone production data for the 5 years from 1969 to 1973, inclusive. For these years, cones produced by sample seed trees in the 11- and 12-inch diameter classes only (10.6-12.5 in d.b.h.) were determined. This provided for a direct comparison of cone production among locations (table 2). Again, two northwest Florida sites and the southwest Georgia site had the lowest cone production.

The practical application of natural regeneration methods for longleaf pine depends on the frequency of cone crops large enough to provide acceptable regeneration. Considering an average of 20 cones per tree as a minimum, the frequency of cone crops this large or larger was determined for each location (fig. 2). These ranged from 0.75 and 0.62 for the two Mountain Province locations to 0, 0.06, and 0.07 for the three Florida-Georgia sites. The overall average frequency of useable cone crops was 0.30 or one crop every 3.3 years. All locations with cone crop frequencies of 0.10 or more have been successfully regenerated (6,000 or more established seedlings per acre), although sometimes this has

Table 2.--Longleaf pine cone production by location

State	County	Cones per tree: All trees, all years	Cones per tree: 11-12 in d.b.h. trees, 1969-73
		-------Average number---------	
LA	Grant	33	14
MS	Perry	16	33
AL	Coosa	86	24
	Perry	71	80
	Escambia	13	12
FL	Santa Rosa	7	9
	Okaloosa	4	7
	Leon	19	12
GA	Decatur	3	5
SC	Chesterfield	30	21
NC	Bladen	7	17

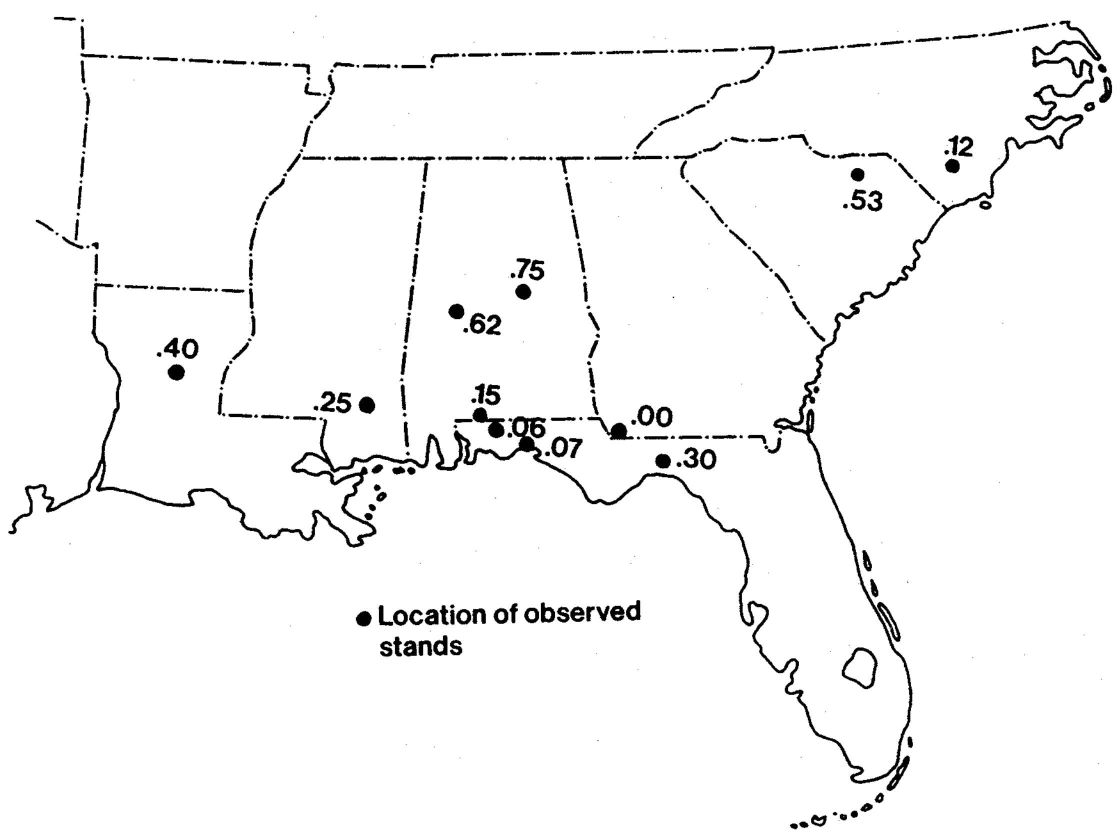

Figure 2.--Frequency of acceptable cone crops in longleaf pine.

been accomplished by two or more smaller cone crops (15-20 cones/tree) rather than a single large cone crop. The three locations with cone crop frequencies of less than 0.10 have not yet been regenerated.

Low cone crop frequencies could be due to failure of trees to flower or to loss of flowers and developing cones, or both. Flower counts (annual average/tree) are given in table 3. Cone counts on each area were compared to associated flower counts obtained from the same trees 2 years earlier and to conelet counts obtained 1 year earlier. The ratios of flowers to cones and conelet to cones were then determined (table 3). Cone crops on each test area during the first 2 years of observation were not counted at the flower stage, so ratios could not be determined for these years. For example, cones counted in the spring of 1967 were from the 1966 cone crop, but the flowers counted at the same time represented the 1968 cone crop.

Table 3.--Average annual flower counts and ratios of flowers to cones and conelets to cones

State	County	Avg. No. flower counts/tree	Flowers /Cones	Conelets /Cones
LA	Grant	36	4.1	0.66
MS	Perry	18	2.1	0.94
AL	Coosa	27	0.5	0.29
	Perry	23	0.5	0.23
	Escambia	28	3.3	0.72
FL	Santa Rosa	21	10.6	0.82
	Okaloosa	12	5.4	0.66
	Leon	16	26.2	1.13
GA	Decatur	18	13.7	1.13
SC	Chesterfield	30	1.2	0.43
NC	Bladen	5	0.9	0.48

Flower production among the 11 locations was much more uniform than the resulting cone production (coefficient of variation of 41 percent for flowers vs. 106 percent for cones). The ratios indicate considerable variation among locations in both flower losses during the first year and losses of developing cones during the second year (table 3). Higher values indicate greater losses. The highest flower losses were recorded at two Florida sites plus the Georgia site. These same sites also had higher than average losses of developing cones. Conversely, the high cone-producing sites in Coosa and Perry Counties, Alabama had the lowest losses of both flowers and developing cones.

An analysis of variance of all data on flower and cone counts indicated that for flowers, the variation associated with year (33 percent) was nearly double that associated with location (18 percent). For cones, the variation associated with location (26 percent) was greater than that associated with year (18 percent). Flower production is highly variable from year-to-year, and in large part this reflects climatic conditions before initiation. Flower losses, however, appear to be associated with location, being more severe some places than others. Final cone crop size, therefore, reflects factors affecting initial flowering and also flower and cone losses.

CONCLUSIONS

Production of longleaf pine cones varies considerably from year-to-year and from place-to-place. Considering the region as a whole, the frequency of cone crops large enough to establish natural regeneration in shelterwood stands is almost 1 year in 3. Among the locations sampled, however, frequency of useable cone crops ranged from 3 years out of 4 to zero. Three locations had cone crop frequencies of less than 1 year in 10. At locations such as these, natural regeneration of longleaf pine may not be a viable option.

Over time, flower production is more consistent among locations than cone production. The evidence in this study suggests that low cone production is associated more with flower losses and, to a lesser extent, cone losses than with failure to flower in the first place.

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